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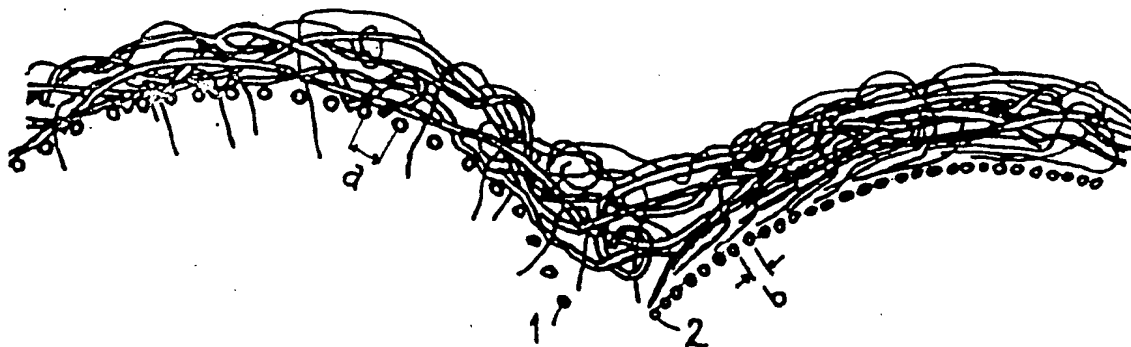
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<b>(21) International Application Number:</b> PCT/SE91/00781 <b>(22) International Filing Date:</b> 18 November 1991 (18.11.91) <b>(30) Priority data:</b> 9003678-1 19 November 1990 (19.11.90) SE <b>(71) Applicant (for all designated States except US):</b> MÖLN- LYCKE AB [SE/SE]; S-405 03 Göteborg (SE). <b>(72) Inventors; and</b> <b>(75) Inventors/Applicants (for US only) :</b> BILLGREN, Tomas [SE/SE]; PL 3560, S-430 41 Kullavik (SE). NYRÉN, To- mas [SE/SE]; Råda Portar 35, S-435 32 Mölnlycke (SE). KÖLBY FALCK, Ewa [SE/SE]; Ångtegsgatan 5, S-416 56 Göteborg (SE).		<b>(74) Agents:</b> KIERKEGAARD, Lars-Olov et al.; H. Albihns Patentbyrå AB, Box 3137, S-103 62 Stockholm (SE). <b>(81) Designated States:</b> AT (European patent), AU, BE (Euro- pean patent), CA, CH (European patent), CS, DE (Eu- ropean patent), DK (European patent), ES (European patent), FI, FR (European patent), GB (European pa- tent), GR (European patent), HU, IT (European patent), JP, LU (European patent), NL (European patent), NO, SE (European patent), SU <sup>+</sup> , US.  <b>Published</b> <i>With international search report.</i> <i>In English translation (filed in Swedish).</i>

**(54) Title:** A METHOD OF HYDROENTANGLING



**(57) Abstract**

The present invention relates to a method of hydroentangling a mixture of staple fibres and pulp fibres, which fibres have been formed on a forming wire with the pulp fibres lain on top of the staple fibres. The inventive method comprises the steps of: subjecting the formed fibrous web to a first entangling process on a fine-mesh wire; subjecting the entangled fibrous web to a second entangling process on a coarse-mesh wire; and transferring the entangled fibrous web obtained in the second entangling process to a fine-mesh entangling wire and there subjecting the web to a third entangling process. The invention results in a spunlace material having good wear resistance on the staple-fibre side.

# + DESIGNATIONS OF "SU"

Any designation of "SU" has effect in the Russian Federation. It is not yet known whether any such designation has effect in other States of the former Soviet Union.

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A Method of Hydroentangling

5 The present invention relates to a method of hydro-  
entangling a mixture of staple fibres and pulp fibres  
which have been formed on a forming wire with the pulp  
fibres lying on top of the staple fibres.

10 Hydroentangling or spunlacing is a method which has  
become increasingly popular in the manufacture of me-  
chanically bonded nonwoven fabrics. The method involves  
projecting jets of water from rows of fine nozzles onto  
a passing fibrous web carried by a liquid-permeable  
15 conveyor belt or wire. The water jets are operative in  
creating mechanical bonds between the fibres in the  
fibrous web and strong nonwoven materials can be pro-  
duced by means of this method. Furthermore, the choice  
of fibres and fibre mixtures for material manufacture is  
practically unlimited when the material is produced by  
20 the hydroentangling method. Such materials have pro-  
nounced textile-like properties compared with other  
fabric cloths, and the entangling method provides a  
relatively high degree of flexibility with regard to the  
properties of the material produced, mainly because the  
25 properties imparted to the material can be varied widely  
by selection of fibres, fibre mixtures, fibre forming,  
degree of entanglement, wire structures, etc. As a  
result, the use of spunlace material has become more  
common.

30 The properties of spunlace material are also influenced  
by a number of other factors, in addition to the manner  
in which the fibrous web or mat is entangled. These  
other factors include the type of fibres included in a  
35 mixed material and the proportions in which the fibres  
are present. An important factor is the manner in which

the fibrous web or fibrous mat to be entangled is formed, i.e. the manner in which the fibres are lain on the wire, the forming wire, which transports the fibrous web to the entangling station.

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When the formed fibrous web consists of two separate layers of mutually different types of fibre which have been lain with the aid of commercially available equipment, there is normally obtained a final product which pronouncedly two-sided to a greater or lesser extent, i.e. has a higher concentration of the one fibre type on one side and a higher concentration of the other fibre type on the other side.

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When the formed fibrous web consists of a homogenous mixture of two types of fibre, however, a homogenous material is obtained.

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It has been found that when dry-defibred pulp fibres are used together with staple fibres, a strong spunlace material can be formed with a relatively low energy input during the entangling process. However, the integrity of the material is not built-up to the same degree with this low energy input. Consequently, the fibres on the staple-fibre side are readily teased or raised when the material is used and such material will appear to be fluffy after becoming worn to some extent. Certain types of disposable materials, however, for example such material as those used in operating theatres or as swabs or wiping-up cloths shall be lint-free in use. A two-sided material whose one side exhibits the aforesaid low wear resistance cannot therefore be used in these areas. The two-sidedness and fluffiness of such materials can be reduced by performing the entangling process at higher energy inputs, although this adds considerably to the cost of manufacturing the

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material in question.

The object of the present invention is to increase the wear resistance, and thus increase the strength of the bonds between the fibres on the staple-fibre side of spunlace material manufactured from a formed fibrous web comprised of a lower layer of air-lain staple fibres and a top layer of pulp fibres, without appreciably increasing the energy input during the entangling process.

This object is achieved with a hydroentangling method according to the invention, which is characterized by the following steps:

- subjecting the formed fibrous web to a first entangling process on a fine-mesh wire;

- subjecting the entangled fibrous web to a second entangling process on a coarse-mesh wire; and

- transferring the entangled fibrous web from the second entangling location to a fine-mesh wire and there subjecting said web to a third entangling process.

By transferring the fibrous web subjected to the first, high-pressure entangling process to a wire of very fine mesh, the fibre ends which project out from the underside of the fibrous web are folded in towards the underside of said web, and the subsequent entangling process causes these fibre ends to be securely bound to the fibres in the fibrous web. This binding of the fibre ends to the underside of the fibrous web increases its resistance to wear. Furthermore, these bound fibre-ends form a network on the underside of the staple fibre-side of the material which reduces the risk of overlying fibre-ends in the material projecting out from said

material in use.

5 According to one preferred embodiment of the invention,  
the duration of the second entangling process is deter-  
mined so that a suitable number of fibre-ends will  
project out through the underlying wire. Thus, the  
invention utilizes, and even amplifies, the occurrence  
of fibre-ends which project through the entangling  
wire, something which is undesirable in conventional  
10 entangling processes.

The fine-mesh wire used in the first entangling process  
maintains the uniformity of the fibrous web during said  
process, and the staple fibres and the wire together  
15 form a very fine network which prevents the short pulp  
fibres from being flushed or rinsed from the fibrous  
web.

20 An exemplifying embodiment of the invented method will  
now be described with reference to the accompanying  
drawing, the single Figure of which illustrates sche-  
matically the transfer of a fibrous web from the second  
to the third entangling wire.

25 Used in the exemplifying embodiment is a 1.5 denier dry-  
defibred pulp fibre having an average length of 2.5 mm.  
These fibres are air-laid on top of a layer of staple  
fibres, which may consist, e.g., of PES, viscose,  
0.8-2.2 dtex and 20-60 mm long, which have been air-lain  
30 on a forming wire with the aid of a conventional staple-  
fibre former, e.g. a former of the Curlator, Rando-  
webber, Ferrer K12, etc. Air-laying of the pulp fibres  
can be effected with a pulp fibre former of the Danwebb  
type, Krøyer type or some other conventional type.

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The formed fibrous web is transferred to a fine mesh first entangling wire of 100 mesh and there entangled. The use of a fine-mesh wire in this stage of manufacture enables the smoothness of the underside of the formed fibrous web to be maintained during the entangling process. Furthermore, the fine wire forms together with the staple fibres an extremely fine three-dimensional network which prevents the short pulp-fibres from being rinsed or flushed out of the fibrous web during the entangling process.

The entangling process is effected with the aid of commercially available equipment sold by Honeycomb Systems Inc. or Perfojet S.A.

Upon completion of the first entangling process, the fibrous web is passed to the second entangling wire of 60 mesh and of smaller open area, and is there again entangled. The bonds between the fibres in the fibrous web obtained during the first entangling process ensure that the pulp fibres on the pulp-fibre side of the fibrous web will not be carried away by the water jets, and that there are not found, at least to any appreciable extent, non-bound short pulp fibres which can be carried by the water jets through the relatively coarse structure of the fibrous web and flushed out through the coarse-mesh wire. However, the water jets will press loose fibre-ends through the coarse meshes in the wire. This takes place to a large extent at the beginning of the second entangling process, when the fibrous web has a relatively open structure.

When the web is entangled solely with the aid of fine-mesh wires, the fibrous web is successively compacted and the structure of the web becomes more and more dense as compaction continues. In this way, those fibre parts

which at the beginning of the high-pressure entangling process were acted upon essentially in a vertical direction by the water jets will be acted upon in a horizontal direction to an ever greater extent, because the vertical water jets are deflected and split-up in horizontal directions to an increasing extent when they impinge on the firmly bound fibres in the fibrous web or on the wires from which the wire is constructed. Thus, the strength of the fibrous web increases very rapidly at the beginning of the high-pressure entangling process, whereas there is no appreciable increase in the total strength of the fibrous web after a certain time has elapsed. Consequently, continued entangling of the fibrous web after this point in time, to ensure that remaining fibre ends which project through the wire will be firmly secured in the web, will not result in any appreciable increase in the strength of the material in its entirety and consequently a large energy input is required in the entangling process in order to provide, in this way, a wear-resistant staple-fibre side of a two-sided nonwoven material. Furthermore, the fine wire in itself represents a limitation to the energy input per unit of time, due to its limited dewatering ability.

When practicing the present invention, the wear-resistance is achieved in a totally different manner while maintaining a low energy input in the entangling process. This is achieved by interrupting the second entangling process before the fibrous web has reached full strength, and by then transferring the fibrous web to a third, extremely fine-mesh entangling wire having a size of 100 mesh. During this transfer, the free fibre-ends that project down from the underside of the fibrous web are folded in against said underside and due to the fine-mesh size of the wire, the inwardly folded fibre-ends will be held pressed against the underside of the



fibrous web over the major part of their lengths. The fibrous web transferred to the third entangling wire is then subjected to a second, high-pressure entangling process in which the inwardly folded fibre-ends can be readily entwined in the fibrous web by the water vortices generated during the entangling process. The reference numeral 1 used in the Figure identifies the transverse wires of the forming wire used in the second entangling process, while the reference numeral 2 identifies the transverse wires of the forming wire used in the third entangling process.

The time at which the transfer from the second to the third entangling wire is effected is not particularly critical. For example, if the transfer is made before a maximum number of downwardly-projecting fibre-ends are obtained in the second entangling process, a wear-resistant stable-fibre side will nevertheless be obtained after the third entangling process, provided that the number of downwardly projecting fibre-ends obtained with the second entangling wire is not excessively small. No further downwardly projecting fibre-ends will occur in the subsequent third entangling stage, since the fine-mesh wire together with the inwardly folded fibre-ends and the outer layer of the underside of the fibrous web form a very fine, three-dimensional network. If the transfer is made shortly after obtaining a maximum number of downwardly projecting fibre-ends in the first, high-pressure entangling process, the number of downwardly-projecting fibre-ends will not have had time to decrease to an extent such as to reduce the wear resistance after the third entangling process. However, in view of energy input, it is preferred to transfer the fibrous web from the second to the third entangling wire before a maximum number of downwardly projecting fibre-ends have formed. To this end, the third entangling

process is also utilized to provide an essential contribution to the total strength build-up of the spunlace material. According to one preferred variant of the inventive method, the transfer to the third entangling wire shall therefore be effected when a "suitable number" of downwardly projecting fibre-ends have formed. By a "suitable number" is meant a number of downwardly projecting fibre-ends sufficient to achieve the requisite resistance to wear of the staple-fibre side after the third entangling process. This suitable number is appropriately determined empirically.

The present invention utilizes the phenomenon that fibre-ends project down through the entangling wire, in order to increase the wear resistance of the staple-fibre side of the manufactured spunlace material, this phenomenon being considered disadvantageous in conventional entangling methods. If the number of downwardly projecting fibre-ends is sufficiently large, a very fine network is formed on the staple fibre-side after the third entangling process, because the inwardly folded pulp-fibre ends are then firmly connected to the fibres present in the underside of the fibrous web. This network prevents overlying free fibre-ends in the fibrous structure from protruding from the resultant spunlace material produced in accordance with the invention, when said material is used.

The mesh size of the second entangling wire is of decisive significance, primarily with regard to the length of the fibre ends which project out through the second entangling wire after the first, high-pressure entangling process. If the mesh size of the wire is too small, the network formed by the wire together with the outer part of the underside of the fibrous web will prevent a sufficient number of downwardly projecting

fibre-ends of sufficient length from being obtained. With larger mesh sizes, there is a risk that holes or irregularities will occur in the fibrous web.

- 5       A 60-mesh wire was found suitable with the fibres used in the above example. The average length, 2.5 mm, of the pulp fibres was thus about six times greater than the mesh width.
- 10       The third entangling wire had a fineness of 100 mesh. The total energy used when entangling the fibrous web was 500 kWh/tonne, of which a third was used for each entangling step.
- 15       It will be understood that the sizes of the wires used in respective entangling processes must be adapted to the nature of the fibres present in the fibrous web, in order to obtain a satisfactory result. A good result can be achieved with those fibres suitable for use when
- 20       practicing the inventive method by a suitable combination of wires within the range of 80-100 mesh in the case of the first entangling wire, 40-80 mesh in the case of the second entangling wire and 100-200 mesh in the case of the third entangling wire.
- 25       Thus, the inventive method enables spunlace material that can be used in operating theatres to be produced at a much lower energy input than the inputs of earlier known entangling processes that are effected on the
- 30       basis of a fibrous web which has been formed by air-laying pulp fibres on top of an air-laid layer of staple fibres. The amount of material wasted when practicing the present invention is also far less than the material wasted when practicing earlier known methods.

Claims

1. A method for hydroentangling a mixture of staple  
fibres and pulp fibres which have been formed on a  
forming wire, with the pulp fibres laid on the staple  
fibres, c h a r a c t e r i z e d by

- subjecting the formed fibrous web to a first en-  
tangling process on a fine-mesh wire;
- subjecting the entangled fibrous web to a second  
entangling process on a coarse-mesh wire; and
- transferring the entangled fibrous web obtained in  
the second entangling process to a fine-mesh entangling  
wire and there subjecting the web to a third entangling  
process.

2. A method according to Claim 1, c h a r a c -  
t e r i z e d in that the wire used in the first en-  
tangling process has a coarser mesh than the wire used  
in the third entangling process.

3. A method according to any one of Claims 1-2,  
c h a r a c t e r i z e d by interrupting the second  
entangling process when a suitable number of fibre-ends  
project downwards from the coarse-mesh entangling wire.

4. A method according to any one of Claims 1-3,  
c h a r a c t e r i z e d in that the pulp fibres are,  
on average, six times longer than the width of the  
meshes in the wire used in the second entangling  
process.

5. A method according to any one of Claims 1-4,  
c h a r a c t e r i z e d by using in the first en-  
tangling process a wire having a size of 80-100 mesh,  
using in the second entangling process a wire having a  
5 size of 40-80 mesh, and using in the third entangling  
process a wire having a size of 100-200 mesh.

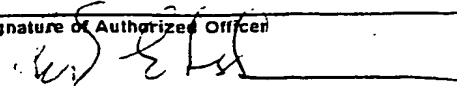
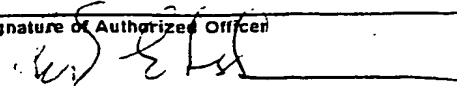
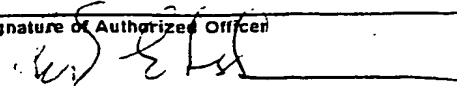
6. A method according to any one of Claims 1-5,  
c h a r a c t e r i z e d in that the formed fibrous  
10 web contains 20-80% dry-defibred 1.5 denier pulp fibres  
and the remainder staple fibres, 0.8-2.2 dtex and  
20-60 mm long.

7. A method according to any one of Claims 1-6,  
15 c h a r a c t e r i z e d in that the energy input when  
entangling the fibrous web is about 500 kWh/tonne.



# INTERNATIONAL SEARCH REPORT

International Application No PCT/SE 91/00781

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) <sup>6</sup> According to International Patent Classification (IPC) or to both National Classification and IPC <b>IPC5: D 04 H 1/46</b>								
<b>II. FIELDS SEARCHED</b> <div style="text-align: center; margin-top: 5px;">Minimum Documentation Searched<sup>7</sup></div> <table style="width: 100%; border: none;"> <tr> <td style="width: 20%; border: none;">Classification System</td> <td style="border: none;">Classification Symbols</td> </tr> <tr> <td style="border: 1px solid black; padding: 5px;">IPC5</td> <td style="border: 1px solid black; padding: 5px;">D 04 H</td> </tr> </table> <div style="text-align: center; margin-top: 5px;">Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched<sup>8</sup></div> <p style="margin-top: 10px;">SE,DK,FI,NO classes as above</p>			Classification System	Classification Symbols	IPC5	D 04 H		
Classification System	Classification Symbols							
IPC5	D 04 H							
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT<sup>9</sup></b> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%;">Category<sup>*</sup></th> <th style="width: 60%;">Citation of Document,<sup>11</sup> with indication, where appropriate, of the relevant passages<sup>12</sup></th> <th style="width: 30%;">Relevant to Claim No.<sup>13</sup></th> </tr> </thead> <tbody> <tr> <td style="vertical-align: top; padding: 5px;">A</td> <td style="vertical-align: top; padding: 5px;">EP, A2, 0351949 (VERATEC, INC.) 24 January 1990, see page 10; claim 8  -----</td> <td style="vertical-align: top; padding: 5px;">1-7</td> </tr> </tbody> </table>			Category <sup>*</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>	A	EP, A2, 0351949 (VERATEC, INC.) 24 January 1990, see page 10; claim 8  -----	1-7
Category <sup>*</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>						
A	EP, A2, 0351949 (VERATEC, INC.) 24 January 1990, see page 10; claim 8  -----	1-7						
<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p><b>* Special categories of cited documents:<sup>10</sup></b></p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&amp;" document member of the same patent family</p> </div> </div>								
<b>IV. CERTIFICATION</b> <table style="width: 100%; border: none;"> <tr> <td style="width: 45%; border: none;">           Date of the Actual Completion of the International Search  <b>20th February 1992</b> </td> <td style="width: 55%; border: none;">           Date of Mailing of this International Search Report  <b>1992 -02- 21</b> </td> </tr> <tr> <td style="border: none;">           International Searching Authority    <div style="text-align: center;"><b>SWEDISH PATENT OFFICE</b></div> </td> <td style="border: none;">           Signature of Authorized Officer  <div style="text-align: center;">   <b>Nils Ekström</b> </div> </td> </tr> </table>			Date of the Actual Completion of the International Search <b>20th February 1992</b>	Date of Mailing of this International Search Report <b>1992 -02- 21</b>	International Searching Authority  <div style="text-align: center;"><b>SWEDISH PATENT OFFICE</b></div>	Signature of Authorized Officer <div style="text-align: center;">   <b>Nils Ekström</b> </div>		
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International Searching Authority  <div style="text-align: center;"><b>SWEDISH PATENT OFFICE</b></div>	Signature of Authorized Officer <div style="text-align: center;">   <b>Nils Ekström</b> </div>							

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**ANNEX TO THE INTERNATIONAL SEARCH REPORT  
ON INTERNATIONAL PATENT APPLICATION NO.PCT/SE 91/00781**

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the Swedish Patent Office EDP file on 30/12/91. The Swedish Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A2- 0351949	90-01-24	JP-A- 2068345	90-03-07
		US-A- 4925722	90-05-15
		US-A- 4959894	90-10-02